81° 25'

Water level, Lake Placid

Discharge, Stearns Creek

200

Vater level, Lake June In Winter

Specific conductance, Lake June In Winter

Total phosphorus, Lake June In Winter

Figure 6.—Precipitation, evaporation, water-table level, lake level, stream

discharge, and water-quality data.

VERTICAL SCALE IS

Figure 4.—Generalized geologic section along the Lake Wales

Ridge (from Hammett, 1981).

LAKE

tightly cased well, May 1981. Contour interval 10 feet. Datum is NGVD of 1929. TECTION OF STREET

1 2 3 4 5 MILES HIOLOGICAL

EXPLANATION

DIRECTION OF STREAM FLOW.

Figure 5.—Lake June in Winter and vicinity

showing the potentiometric surface of the

Floridan aquifer May 1981 (from Schiner and

--- BASIN BOUNDARY.

Lake June in Winter is in central Highlands County near the town of Lake Placid in south-central Florida (fig. 1). The lake is in a chain of lakes connected by canals and creeks and is the second largest lake (second to Lake Istokpoga) in Highlands County. The surface area of the lake is 3,662 acres (5.7 mi²) and it has a drainage area of 44 mi². The altitude of the water surface averages about 74 feet, with lake depths of more than 40 feet. Recreation and irrigation of citrus groves are the major lake uses. Lake Placid, which is almost as large as Lake June in Winter, receives the drainage from the upper half of the drainage basin of Lake June in Winter and discharges much of this drainage into Lake June in Winter. Lake June in Winter was formerly called Lake Stearns, and Lake Placid was formerly called Lake Childs (Bishop, 1956,

Lake June in Winter was selected for study as part of a continuing investigation of Florida lakes conducted by the U.S. Geological Survey in cooperation with the Southwest Florida Water Management District. The the lake basin. The scope of the study included the compilation and evaluation of antecedent data; however, some additional data were collected during the study regarding lake depths, water levels in wells of the surficial aquifer and Floridan aquifer, and selected physical measurements and chemical

analyses of lake and well water. A summary of the data is available from 27 sites in and near the study area (table 1 and figs. 2 and 3). Five sites were used to collect rainfall data (3 for quantity and 2 for quality), 1 for evaporation quantity, 9 for quantity or quality of water in the surficial aquifer, 2 for quantity or quality of water in the Ploridan aquifer, and 10 for quantity or quality data of the surface waters. The period of record includes data from 1945 through 1982. Two reports on the general hydrology and geology of the Lake June in Winter area have been published previously. Bishop (1956) discusses the geology and ground-water resources of Highlands County, and Kohout (1959) and Kohout and Meyer (1959) discuss the hydrologic features of the Lake Istokpoga and Lake Placid areas, which include about half of the Lake June in

Milleson (1978) investigated the limnology of seven lakes within the Istokpoga basin. He included data on water quality, biology, and lake depths in a report released by the South Florida Water Management District. mett (1981) described the hydrology of Lake Jackson, at Sebring. Bishop 1967) describes high-water lines and shoreline classifications of Lake June in Additionally, the U.S. Geological Survey periodically releases data reports on water levels, discharges, and water quality for the area lakes, streams, and wells in its series "Water-Resources Data for Florida."

ENVIRONMENTAL SETTING The climate at Lake June in Winter is subtropical, characterized by rainy humid summers and dry mild winters. The summer rains usually occur as local afternoon thundershowers. On a regional basis, Macvicar (1981, p. 60, 61, 63) estimates that, on the average, annual rainfall will be at least 64 inches once in 10 years; 74 inches once in 25 years; and 86 inches once in 100 years. The population in Highlands County increased from 29,507 in 1970 to 47,526 in 1980, an increase of 61.1 percent (University of Florida, 1981). Most of the population of Highlands County is on the Lake Wales ridge, the center of the county's tourist industry. Tourism increases the population appreciable in the window production appreciable in the window product. preciably in the winter months.

Land use around Lake June in Winter is residential on the northern and southern shores, undeveloped on the western shore, and agricultural (citrus) on the eastern shore. The total shoreline is approximately 13.9 miles with 5.3 miles undeveloped (38 percent), 3.0 miles citrus (22 percent), and 5.6 miles residential (40 percent) (Milleson, 1978, p. 26). Most land use of the 44 mi² of drainage area is undeveloped with small parts being used for residential, citrus, and pasture purposes.

Four major lithologic units underlying the Lake June in Winter area are

shown in the generalized geologic section (fig. 4). The uppermost unit is composed of fine-to coarse-sand ranging in thickness from about 130 to 225 feet. This unit is underlain by a unit of undifferentiated sand and clay ranging in thickness from about 50 to 200 feet. The sand and clay unit is underlain by 50 to 60 feet of clay. This clay unit is underlain by limestone and dolomite. The surficial aquifer is composed of the fine- to coarse-sand lithologic unit. The sand and clay and clay lithologic units make up a relatively impermeable confining layer to the underlying Floridan aquifer. The Floridan aquifer is composed of the limestone and dolomite of the Suwannee Limestone, Ocala Limestone, Avon Park Limestone, and Lake City Limestone. Although most of the water in the surficial aquifer moves horizontally, some water moves downward through the confining layer to the Floridan aquifer (Bishop, 1956,

Wells in the surficial aquifer supply much of the water required for domestic, stock, and small irrigation uses in Highlands County. The Floridan aquifer supplies most large irrigation and municipal water supply users. BASIN AND LAKE CHARACTERISTICS Lake June in Winter lies in the Intraridge Valley of the Lake Wales Ridge (White, 1970, p. 120). The ridge is an undulating upland that ranges in altitude from 40 to 160 feet. Many circular lakes and sinks have developed in the Intraridge Valley as a result of differential solution of the limestone that underlies the area (White, 1970, p. 119-120). The surface sediments have been estructured by wind and wave action to form sand dunes and bars. The terrain of the Intraridge Valley in the Lake June in Winter area slopes steeply rising from a lake surface altitude of about 73 feet to about 150 feet on the east side, and to about 120 feet on the west side. From the vicinity of Sebring, drainage of the Intraridge Valley is southward to Josephine Creek; and from the vicinity of Archbold the drainage is northward to Josephine Creek (fig. 5). Josephine Creek drains to Lake Istokpoga (fig. 5) which drains to the Kissimmee River and Lake

Lake June in Winter is the second largest lake in the Intraridge Valley chain of lakes south of Josephine Creek. It receives inflow from Lake Placid, the first large lake in the chain, by Catfish Creek (called Catfish Bay Canal by Kohout and Meyer, 1959) and discharges north through Stearns Creek to Lake Francis. The flow of water to Lake June in Winter is controlled by of 93 feet, water will flow through the culverts from Lake Placid to Lake June in Winter. Thus, the contributing drainage area of Lake June in Winter is 23.8 mi² when the altitude of Lake Placid is less than 93 feet, and 44.0 mi² when it Water-surface levels in Lake June in Winter were controlled by a 10-bay stop-log control in Stearns Creek from March 1955 until Februar 1968, and by a series of 1- and 3-culvert stop-log structures from February 1968 until August 1976. A 2-bay vertical lift control structure, designat G-90 by the South Florida Water Management District, was constructed in August 1976 (Milleson, 1978, p. B-5). The Southwest Florida Water Management District attempts to maintain the water-surface altitude between 73.5

damage from high stages.

The bottom of Lake June in Winter was mapped using a recording fathometer in February 1981 (fig. 3) when the altitude of the lake was 72.9 feet. The greatest depth measured was 42 feet, about 4,000 feet from the western shore near the center of the lake. From interpretation of fathometer trace, the lake bottom is generally firm sand at depths of less than 10 feet and at depths between 20 and 30 feet. At depths between 10 and 20 feet, the bottom is generally sand and clayey silt that contains aquatic vegetation. Milleson (1978, p. 78) discusses the importance of submergent aquatic vegetation as a unique habitat for benthic fauna in Lake June in Winter. He found the diversity of species to be greatest near he undeveloped shore and least near the residential shore. At depths great than 30 feet, the percentage of clayey silt increases with depth so that at the deepest part of the lake the bottom is totally clayey silt.

and 75.0 feet in order to provide water for irrigation and to prevent property

HYDROLOGIC CYCLE OF THE LAKE The hydrologic cycle is the natural movement of water between the oceans, the atmosphere, and the Earth's land surface. The main phases of this movement are precipitation, evaporation and transpiration, and runoff on and below the ground. Following is a description of each of these phases of the hydrologic cycle in the Lake June in Winter area.
Rainfall data for the lake area are available at three sites: Avon Park, about 20 miles to the north, which has discontinuous data from 1905 to 1981; Lake Placid, which has discontinuous data from 1934 to 1968; and Archbold Biologic Station, which has continuous data from 1969 to the present. Average, maximum, and minimum values of annual rainfall totals are based on the 1945-80 record. The Lake Placid and Archbold stations, which are 8 miles apart, are considered sufficiently close so that the mean annual rainfal for Lake Placid during the period 1945-80 could be computed using the Archbold data for the period 1969-80. The average annual rainfall for 1945-80 for Lake Placid is 51.77 inches, and 53.18 inches for Avon Park. The maximum annual rainfall at Lake Placid during this period was 74.71 inches, occurring in 1953, and 80.08 inches at Avon Park, also occurring in 1953. The minimum annual rainfall at Lake Placid, 32.46 inches, occurred in 1967, and at Avon Park, 34.86 inches, occurred in 1955. The maximum difference between the annual rainfalls at the two sites was in 1963 when Avon Park had 21.70 inches more rainfall than Lake Placid. Rainfalls in excess of 70 inches, such as occurred in 1947, 1953, and 1960, have not occurred since 1960 (fig. 6). Evaporation from lakes and reservoirs is an important component of the hydrologic cycle, it is, however, difficult to measure. Annual lake evaporation can be estimated by applying a coefficient to annual recorded pan evapora-tion data. It has been reported that the ratio of annual lake-to-pan evaporation (pan coefficient) for a standard Weather Service Class A pan at Belle Glade and Lake Okeechobee, about 70 miles to the southeast, site 6, was 0.81 for the period 1940-46 (U.S. Geological Survey, 1954, p. 128). The annual lake evaporation of Lake June in Winter was estimated by applying a coefficient of 0.81 to the annual pan evaporation recorded at Belle Glade by the National Oceanic and Atmospheric Administration (fig. 6). On this basis, the mean estimated annual lake evaporation was 50.10 inches for the period 1945-80. The yearly values were found to range between 47 and 58 inches.

One to three measurements of water levels in the surficial equiforman One to three measurements of water levels in the surficial aquifer were made at six sites near Lake June in Winter (table 1 and fig. 3).

Altitude of water level above National

Well No. Feb. 25, 1981 Apr. 16, 1981 Sept. 22, 1981 106.58 73.16

Contour maps of the water table for March 13, 1956, and July 10, 1956 are given by Kohout and Meyer (1959, fig. 13-14). The contour maps differ slightly but their configuration is generally the same, and they probably closely represent current conditions. The March 13, 1956 contour map, with lake altitudes taken from topographic maps added, is partially reproduced in figure 7. The water surfaces of the lakes are the visible expressions of the water table. Ground water flows toward Lake June in Winter from the west, south and east. The approximate gradients are 16 feet are risk from the west, south, and east. The approximate gradients are: 46 feet per mile from the west, 42 feet per mile from the southwest, 13 feet per mile from the south, and 8 feet per mile from the east. The hydrograph of data available for the years 1958 to 1971 for surficial-

The hydrograph of data available for the years 1956 to 1971 for surficial aquifer well Improved Pasture 2, site 15 (fig.3), is shown in figure 6.

Contours on the potentiometric surface of the Floridan aquifer in May 1981 (fig. 5) indicate that the altitude of the potentiometric surface is about 60 feet, or about 12 feet lower than the lake level in the vicinity of Lake June in Winter. Consequently, a head difference of about 12 feet exists, which tends to drive water from the lake and surficial aquifer into the Floridan aquifer. Although insufficient data are available to quantify seepage from Lake June in Winter to the underlying surficial and Floridan aquifers, some seepage probably occurs because it is unlikely that any completely impervious material lies between the lake and the Floridan aquifer.

A stage hydrograph for Lake June in Winter from April 1945 to 1980 is shown in figure 6. The maximum daily altitude was 77.58 feet in October 1948. The minimum daily altitude recorded was 71.62 feet in May 1981. The lake was not controlled prior to March 1955. The effect of control of the stage of Lake June in Winter on the fluctuation of the stage relative to the fluctua-tion of the stage of Lake Placid can easily be seen in figure 6. Prior to 1955, the peak stages were as much as 3 feet higher than the stages since 1955. Surface flow into Lake June in Winter is from Catfish Creek and direct surface drainage, but the amount is unknown. Discharge from the lake is through Stearns Creek. Flow data for Stearns Creek, site 26, are available from 1955 through 1967 (fig. 6). The average discharge for the 12 years is 26.6 ft³/s. The maximum daily discharge, 431 ft³/s. occurred on September 17, 1960, and the minimum was zero flow for several days during 1960, 1963, and 1967 (U.S. Geological Survey, 1975, p. 304).

An excellent means of studying the water quality of an area is to assess water quality as a system, observing all inputs, outputs, and processes that may affect the system. For Lake June in Winter, this approach can be used by observing the quality of the water as it passes through the hydrologic cycle, first as rainfall, then as surface water in upstream canals and lakes, ground water in the surficial aquifer, and finally, the water in the lake itself. For this assessment, the water-quality constituents and properties included selected physical data, major constituents, and such biological factors as nutrients, dissolved oxygen, and phytoplankton.

Water-quality data were collected by the U.S. Geological Survey and the FDER (Florida Department of Environmental Regulation) during 1965-81.
Those data collected by the FDER are noted in table 5. The locations of the precipitation water-quality data sites used in this report (sites 4 and 5, fig. 2) are about 50 miles southeast of Lake June in Winter, at LaBelle in Hendry County and at Moore Haven in Glades County; however, the quality of precipitation at these sites is probably typical of inland peninsular Florida including the study of the study. land peninsular Florida, including the study area. Selected physical characteristics are summarized in table 2. At LaBelle, site 4 umho/cm (micromho per centimeter) at 25 °C, and at Moore Haven, site 5. the mean specific conductance of 6 rainfall samples taken in the same time period was 31 umho/cm (Irwin and Kirkland, 1980, p. 58, 60). Specific conductance of water in the surficial aquifer was found to vary with land use. The mean specific conductance of one to two samples taken during 1980-81 from three wells, sites 7, 8, and 9, in the surficial aquifer in the undeveloped area west of Lake June in Winter ranged from 30 to 42 umho/cm, only slightly higher than the values for rainfall. In a residential and improved pasture land-

use area, two samples taken during 1980-81 from two surficial aquifer wells, sites 10 and 14, had higher specific conductances of 68 and 125 umho/cm, respectively, which probably reflects a light to moderate use of fertilizer in these areas, or septic tank discharge in the residential area. In a citrus grove area, one to two samples taken during 1981 from two surficial wells, sites 11 and 12, had a mean specific conductance just less than 500 umho/cm, indicating a heavier use of fertilizer in this area. The mean conductance for 101 samples from Lake June in Winter, site 22, during the period 1964-82, was 126 umho/cm, a value in the range that would be expected for a blend of surface runoff and ground-water flow into the lake from citrus, residential, improved pasture, and undeveloped land-use areas.

The mean specific conductance of 3 samples taken during 1976-79 from 2 wells in the Floridan aquifer, sites 16 and 17, was 350 and 170 umho/cm. High specific conductance values of water in the Floridan aquifer is usually the result of the dissolution of mineral matter dissolved from the limestone and delamits. dolomite. Even though seepage from Lake June in Winter may affect the no effect on the lake unless ground water from the Floridan is pumped into

Color varied from 0 platinum-cobalt units for rainfall, sites 4 and 5, to 720 n-cobalt units in the surficial aquifer at the Improved Pasture well 1 site 14. The high color in some waters (sites 7, 14, 18, 19, and 20) is probably related to leaching of compounds from organic debris. Lake June in Winter has relatively low color, indicating that water entering the lake has not remained in contact with organic materials for extended periods.

The turbidity was higher in well Undeveloped 1, site 7, and well Grove 1, site 11, than the other sites in the area. It is unknown why these two sites would have a higher turbidity than adjacent wells, well Undeveloped 3, site 9, and Grove 2, site 12. Major-constituent data are summarized in table 3. Stiff diagrams of major

dissolved constituents are shown in figure 8. The principal ionic composition of the precipitation, site 4 and 5, is sodium, bicarbonate, and chloride (table 3). As in the case of specific conductance, the ionic composition of water from the urficial aquifer varies with land use. In the undeveloped area and the improved pasture area, sites 7, 8, 9, and 14, the principal ionic composition is sodium and chloride (fig. 8). It seems likely that this composition is due to socium and chiorace (fig. 6). It seems likely that this composition is due to concentration of constituents in rainfall by evaporation and soil reactions which change the ionic composition of water in the surficial aquifer. Water from the surficial aquifer in the residential area, the canals, and Lake August, sites 10, 18, 19, and 20, is of a calcium sodium and sulfate chloride composition (fig. 8). In the citrus groves, site 11 and 12, the water is of calcium magnesium and sulfate chloride nitrate composition. The major ionic composition of Lake Placid (site 21) is sodium and chloride. Lake June in Winter water, site 22, has an ionic composition that is generally of a mixed cationanion type. The fact that the lake water is not of the same type as Lake Placid is another indication of surficial ground-water inflow. A summary of nutrients, dissolved oxygen, and phytoplankton data is shown in table 4. Total nitrogen concentration is less than 1 mg/L in water from the surficial-aquifer wells in the undeveloped areas, improved pasture area, and the residential area, sites 7, 8, 9, 10, and 14. Water from groves 1 and 2 wells, site 11 and 12, had total nitrogen concentrations of 34 and 28 mg/L, respectively. The high values of total nitrogen in water from the grove areas are probably caused by nitrogen fertilizers used within the groves. Most surface-water sites had total nitrogen concentrations slightly in excess of 1 mg/L; Canal A, site 18, had 1.3 mg/L; Canal J, site 19, had 1.4 mg/L; and Lake August, site 20, had 1.6 mg/L. The total nitrogen concentration of water in Lake June in Winter, site 22, is 0.60 mg/L. The nitrogen-species composition for most data sites are illustrated in figure 9, which shows plots of organic nitrogen, ammonia, and nitrite + nitrate as percentages of total nitrogen on a trilinear graph. The grove wells, sites 11 and 12, are set apart from other plots because of the high nitrite + nitrate values on indirection of the new of interest features.

nitrate values, an indication of the use of nitrate fertilizers in the grove areas. Plots for sites 5 and 7, Moore Haven rainfall and surficial aquifer Undeveloped 1, near the center of the graph, indicate more evenly distributed speciation of nitrogen here than at the other sites. Sites 8 and 9 (surficial aquifer in undeveloped area) are at the bottom center of the plot indicating high percentages of ammonia and organic nitrogen, perhaps due to soil leaching or the presence of organic material. The remainder of the sites are in the corner of the plot where the percentage of organic nitrogen is high and ammonia and nitrite + nitrate is low, indicating little organic waste contamination in the form of ammonia and the absence of oxidation of the organic nitrogen to nitrite and nitrate. two governmental agencies, the U.S. Geological Survey and the Florida Department of Environmental Regulation, is presented in table 5. The range of data values is not large even though sampling locations and time periods are different. For example, specific conductance ranges from 90 umho/cm at the northwest bay, site 22, to 170 umho/cm at northeast and north parts o the lake, sites 24 and 25. The transparency of the lake water ranges from 39 inches (3 feet, 3 inches) at the boat ramp, site 23 to 168 inches (14 feet) in the northwest bay, site 22. Dissolved oxygen concentrations in the lake are high. The minimum value of 5.7 mg/L at a 15-ft depth at 11:30 a.m., August 31, 1978, was at the northwest bay, site 22, and is one of 49 observations available at this site. The maximum value of 11.6 mg/L at a depth of 1.0 ft at 9:20 a.m., January 27, 1977 was at the same site. The saturation concentration of dissolved oxygen is a function of atmospheric pressure and the temperature of the water; primary production, the production of oxygen by plants, can cause the dissolved oxygen concentration to rise above the saturation concentration. Most values for dissolved oxygen concentrations observed in Lake June in Winter ex-

oxygen for Lake June in Winter, site 22, collected in the afternoons of February 13, 1976, May 26, and August 31, 1978, are shown in figure 10. Temperatures were nearly constant with depth in February and August, but show a difference of nearly 4 °C in 16 feet in May. Evidently, the upper zone of ake water was in a warming trend at the time of the May data collection. Th erature for the February data is about 17°C, and for the August data about 30°C. These temperatures are probably representative of the annual range in temperature for Lake June in Winter. The absolute extremes of record at this site are 13 °C to 33 °C (table 5).

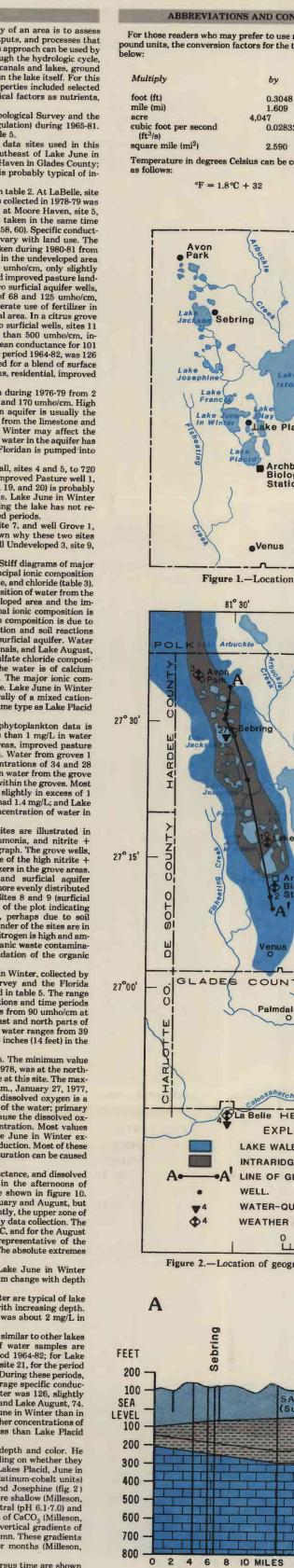
Vertical depth profiles of specific conductance in Lake June in Winter howed little variation with depth or time. The maximum change with depth 0 umho/cm in 6 feet in February 1976. The profiles of dissolved oxygen in Lake June in Winter are typical of lake oxygen profiles in that they show decreasing oxygen with increasing depth. The maximum change of dissolved oxygen with depth was about 2 mg/L in both May and August 1978. In general, the water quality of Lake June in Winter is similar to other lakes that have been investigated in the area. Analysis of water samples are available for Lake June in Winter, site 22, for the period 1964-82; for Lake Jackson, site 27, for the period 1965-78; for Lake Placid, site 21, for the period 1966-82; and for Lake August, site 20, for 1981 (table 2). During these periods, at the indicated sites, the following was found: the average specific conductance in umho/cm of all samples for Lake June in Winter was 126, slightly greater than that for Lake Jackson, 93, Lake Placid, 71, and Lake August, 74. ne major ions were generally slightly higher in Lake June in Winter than in phytoplankton than Lake Jackson but considerably less than Lake Placid Milleson (1978) categorizes area lakes according to depth and color. He found that the water quality of area lakes varies depending on whether they are clear and deep or dark and shallow. He found that Lakes Placid, June in

Winter, and Clay (fig. 2), have low color (11.6 to 22.2 platinum-cobalt units) and are relatively deep. Lakes Istokpoga, Arbuckle, and Josephine (fig. 2) have high color (119.2-160.8 platinum-cobalt units) and are shallow (Milleson, 1978, p.81). Lakes in the area are slightly acidic to neutral (pH 6.1-7.0) and quite soft, with alkalinity ranging from 5.5 to 17.0 mg/L of CaCO₃ (Milleson, 1978, p. 81). Typically lakes in the area have moderate vertical gradients of temperature, pH, and dissolved oxygen in the water column. These gradients are usually more pronounced during the warm summer months (Milleson, Plots of specific conductance and total phosphorus versus time are shown in figure 6. A slight increase in value and variability of specific conductance from the 1960's to 1980 can be seen. Specific conductance was generally less than 120 umhos/cm before 1975 and greater than 120 umhos/cm after 1975. The phosphorus concentration varies from 0.054 mg/L to 0.001 mg/L, but no discernible trend is evident in the phosphorus concentration in relation to

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ceeded saturation, indicating high levels of primary production. Most of these observations were made in the afternoon when supersaturation can be caused Vertical depth profiles of temperature, specific conductance, and dissolved

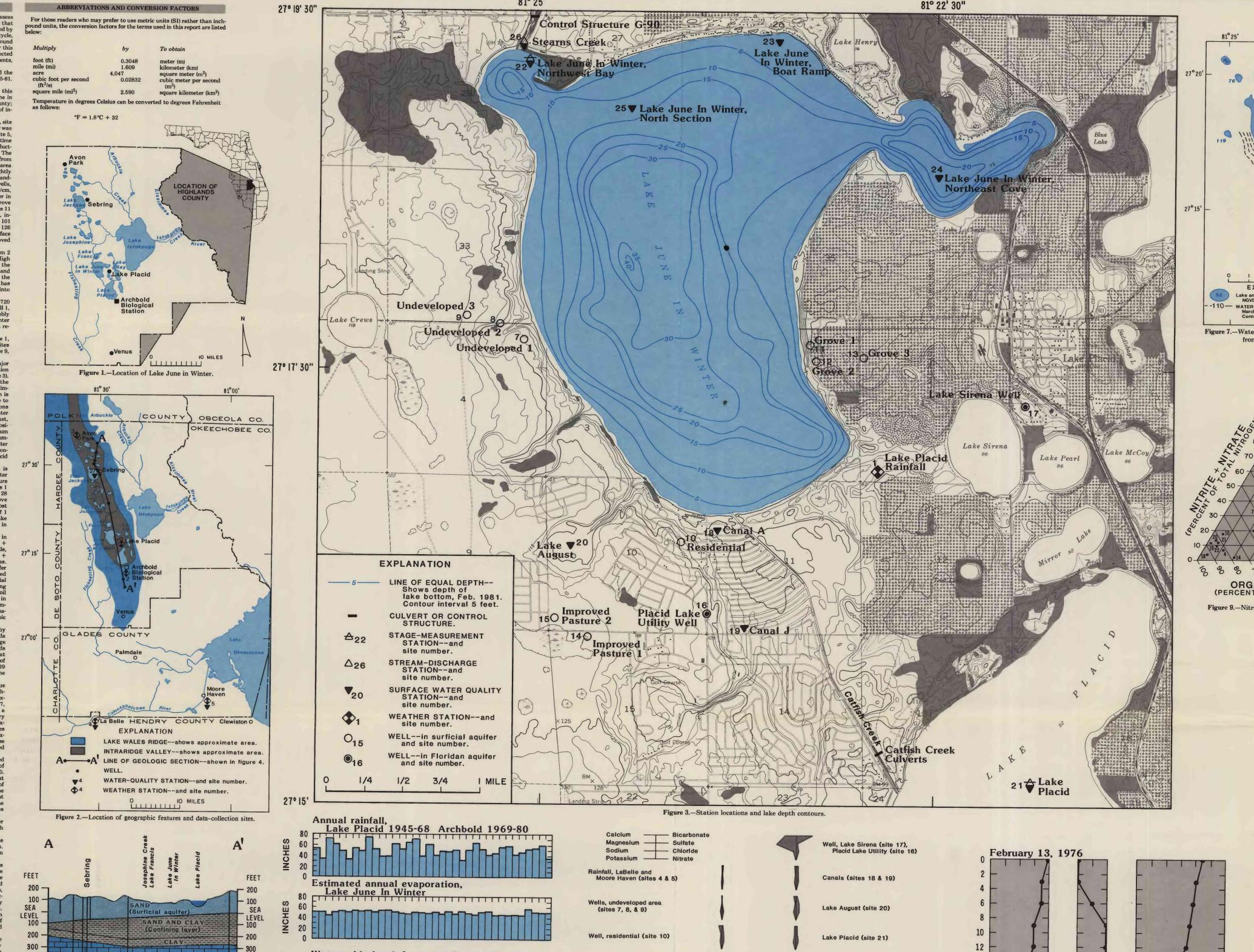
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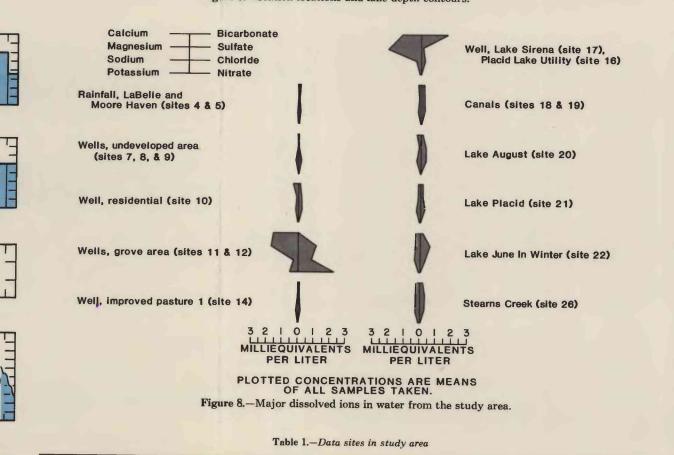
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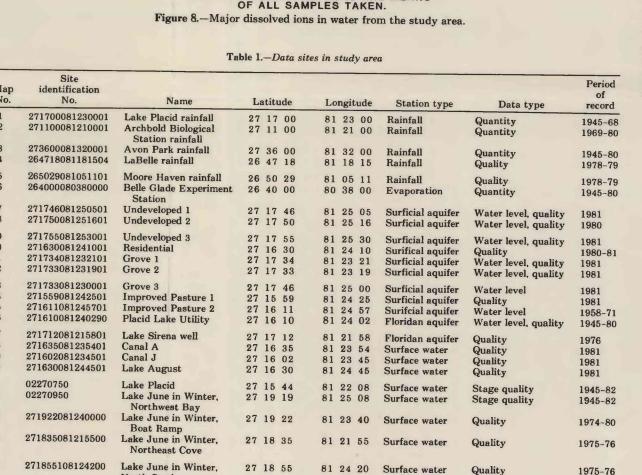
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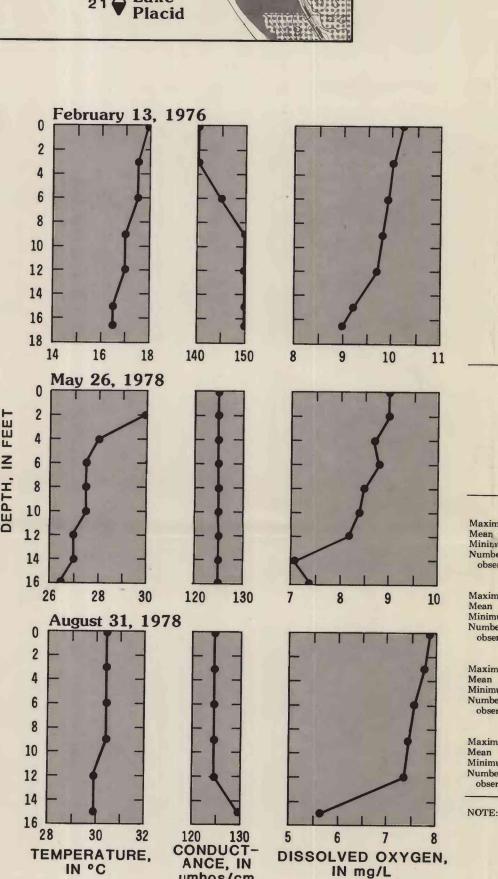
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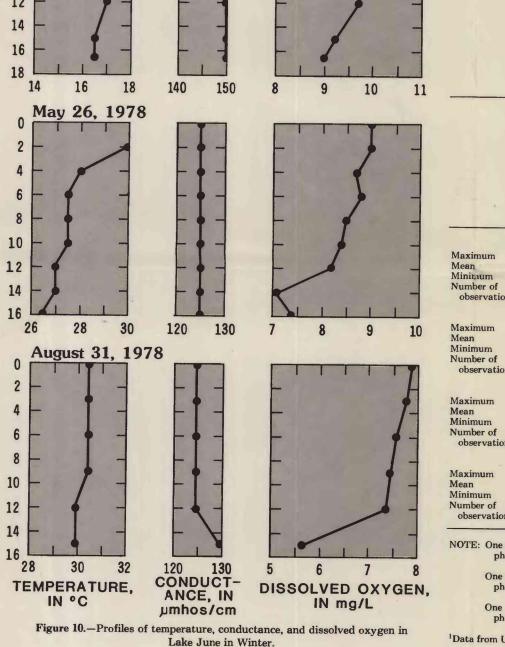
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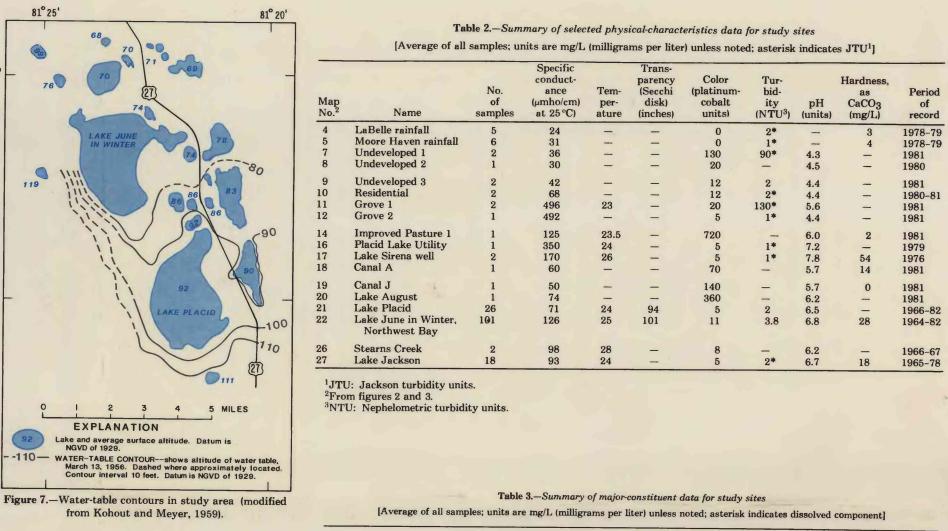


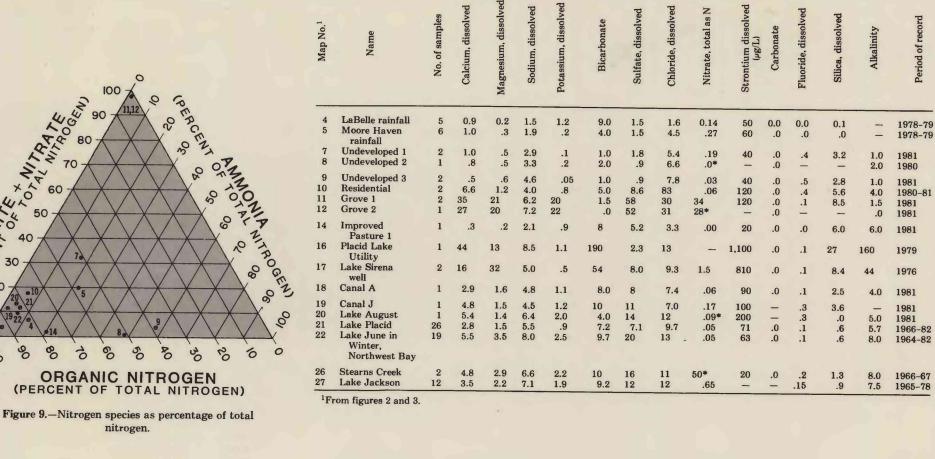


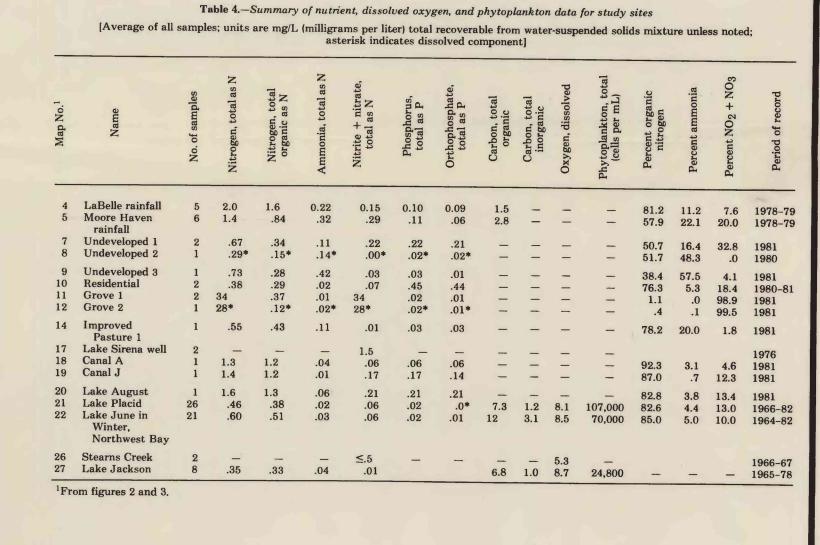












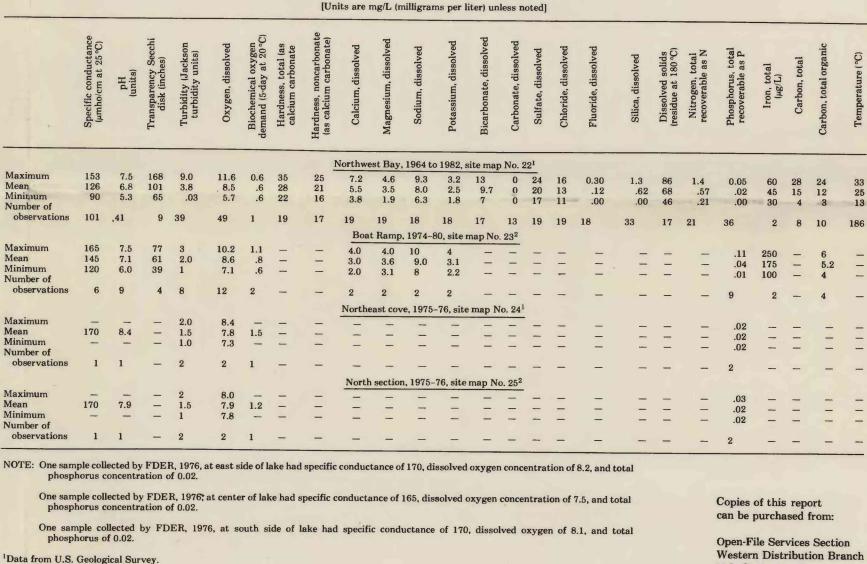


Table 5.—Summary of selected chemical data for Lake June in Winter

Data from U.S. Geological Survey.

²Data from Florida Department of Environmental Regulation, 1976.

U.S. Geological Survey Box 25425, Federal Center Denver, Colorado 80225 (Telephone: (303) 236-7476)

HYDROLOGY OF LAKE JUNE IN WINTER, HIGHLANDS COUNTY, SOUTH-CENTRAL FLORIDA

North Section

Stearns Creek

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